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COMPARING INDUCTIVE AND DEDUCTIVE METHODOLOGIES FOR DESIGN PATTERNS IDENTIFICATION AND ARTICULATION

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ABSTRACT:

Design patterns offer a valuable format to communicate knowledge of successful design solutions to recurring problems. However, there is a lack of research into design patterns that differentiate the applicability of the proposed design solutions across different nations. This paper discusses inductive and deductive methodologies for analyzing qualitative data in order to identify and articulate design patterns for cross-cultural computer-supported collaborative design learning. It proposes a methodology how patterns for facilitating intercultural design education can be identified and articulated. Within this research, an inductive, deductive

and comparative methodology for identifying and articulating design patterns was developed. Therein, eleven patterns for intercultural computer-supported collaboration were identified and written. This paper introduces the proposed methodology taking the design pattern “MOOD OF THE MOMENT” for example.

I. INTRODUCTION

Over the past 40 years, several theories and methodologies to study collaborative interaction were established in the research field of computer-supported collaboration (Schmidt, 1991), (Ellis and Wainer, 1994). Some researchers proposed the format of design patterns to study and report findings from situated studies in computer-supported collaborative interaction. Those researchers developed methods to identify patterns using naturalistic and qualitative research approaches (Hughes et. al., 2000), (Martin et. al., 2001). Dourish (2006) claimed that ethnography could be used as an open-ended approach to gather requirements for a design. Hence, researchers explored the design patterns format for reporting design requirements from ethnographic data (Martin and Sommerville, 2004).

Alexander proposed in his seminal work on design patterns, that a pattern describes a successful solution to a problem in a specific context (Alexander, 1979). He proposed that reoccurring successful design solutions could be experienced, observed and communicated to designers in design patterns. Although researchers reported positively about using qualitative methodologies to find design patterns in ethnographic data, there are less detailed reports about the use of different qualitative analysis approaches of ethnographic data to articulate design patterns (Martin and Sommerville, 2004).

Traditionally, an ethnographer develops topics of interest and concern in interaction with the data. As the analysis progresses, more concrete topics evolve through the recognition of similarities in the observations (Tesch, 1990). This is also called interpretational analysis. Literature distinguishes between inductive and deductive processes of analysis (Tesch, 1990), (Patton, 2000). While the inductive analysis is grounded in the data, a theoretically informed analysis framework guides the deductive analysis.

This paper discusses and compares the above-outlined approaches at the example of the identification and articulation of one design pattern entitled MOOD OF THE MOMENT that was observed supporting cross-cultural computer-mediated collaborative interactions. In conclusion, the paper will present a methodology that employs inductive analysis methods to identify patterns, deductive methods to structure and format patterns and comparative methods to evaluate the applicability of patterns across cultures.

2. BACKGROUND

Since Alexander's (1979) seminal work on design patterns in the field of architecture 30 years ago, this particular concept of sharing and communicating design knowledge has gained attention and acceptance in numerous design related domains. Design patterns convey and communicate design knowledge in a specific format, which was said to enable participants from different backgrounds to engage in a common design process using this "lingua franca" (Erickson, 2000a). Patterns enable the solution of "real world" problems because they capture and allow reuse of experiences of best practice in a specific professional domain. Patterns communicate expert insight to novices by showing more than just the solution. A solution is an answer to a particular question. Contextual constraints offer a rationale and articulate the trade-offs using this solution. The solution is illustrated with examples and underlined with principles. Such multi-faceted information allows the designer to consider the consequences when using a pattern. Moreover, a pattern does not stand on its own. Patterns are embedded into collections of related solutions, which supports the reuse of a successful practice more than a single solution would.

Nevertheless, one may criticize that there are barely any descriptions of solid methodologies for identifying patterns. There is a pattern language to construct patterns (Meszaros and Doble 1999) and there are shepherding processes to improve patterns, but there are only a few studies that offer and explain a clear methodology of design pattern detection (Martin et al., 2001), (Brouns et al., 2005), (Baggetun et al., 2007). Within this field, inductive processes and theoretically informed, deductive processes for identifying and analyzing design patterns in data from fieldwork can be found. A representative work for the inductive method is the approach used by the Lancaster group around David Martin and John Hughes (Hughes et al., 2000). They use an ethnomethodological method to identify design patterns in collaborative work and in domestic environments. Drawing upon several case studies from the field, researchers aimed at finding an analytical framework of design problems and solution that could be illustrated through detailed descriptions, which are usually the delivery format of ethnographic findings (Hughes et al., 2000), (Martin et al., 2004). In opposition, Guy (2003, 2005) uses activity theory tools to analyze the data deductively. It might be debatable which approach is more effective and accurate. Baggetun et al. (2007) proposed an interesting answer. In fact, deductive and inductive processes often go hand in hand. A pattern can be written based on recurrent observations of many instances, but a pattern can also be written based on the knowledge of general concepts in the field, which are used to analyze the observations.

Knowing about a successful solution often leads to identifying a pattern. However, the application of a pattern begins with identifying the problem. Unfortunately, pattern composers often have problems identifying the

problem upon which a solution is based. This shortcoming might originate in the fact that experienced practitioners intuitively apply solutions which proved to work well in a certain context. Over the years, the original problem to this solution might become blurred. Conversely, in usability evaluation of systems, problems using the system become apparent. However, matching an appropriate solution to the observed problem might be difficult. To bridge this gap, a pattern composer needs to determine the appropriate scope of applicability of a pattern.

After reviewing the scope of a set of pattern languages, Mahemoff and Johnston (2001) argue that limiting the scope of design patterns to one application domain supports the use of a pattern language in this domain. In view of supporting design for different target cultures, they argue that, in addition to designing for obvious cultural differences in international system like metrics or language, cultural factors that influence the interaction with systems need to be captured (Mahemoff and Johnston, 1999, 2001). This leads to the thought that there might be a need for a commonly understood language in supporting the culturally sensitive design of products and systems. This paper argues that it is important to choose the appropriate design pattern scope, format and content structure to convey knowledge to its users and enable them to use this knowledge and communicate with others. Pattern users look for problems and pattern composers see the solutions first. When aiming at composing patterns for cross-cultural computer-supported collaboration, it would make sense to identify reoccurring problems and successful solutions at the same time in order to bridge the gap between purpose and articulation of the patterns. This would require a situated study looking at the entire activity system.

3. RESEARCH METHODOLOGY

It has been demonstrated that interaction design patterns can be identified using situated and qualitative research approaches (Guy, 2003, 2005), (Martin et al., 2001, 2004), (Arvola, 2006). Although researchers reported positively about using ethnomethodological, action research and ethnographic approaches to identify design patterns, there are fewer detailed reports about the use of different qualitative analysis approaches to articulate patterns from ethnographic data.

The scarcity of concrete descriptions of analytic processes in the above mentioned approaches might be based on the characteristics of the analysis process. Literature on qualitative analysis agrees that although the process is systematic and comprehensive, it is not rigid. The analysis process is not linear in the way that data analysis follows the data collection, but analysis and collection are cyclic and mutually dependent. Procedures are not mechanistic and there is no standard method. While researchers reflect on the data through

comparisons, they aim at a higher-level synthesis (Tesch, 1990), (Patton, 2002). This was also demonstrated in the analysis of engineering design processes by Bucciarelli (1996). Traditionally, the ethnographer develops, in interaction with the data, topics of interest and concern that evolve through the recognition of similarities in the observations (Tesch, 1990). This process distinguishes in the interaction with the data between inductive and deductive processes (Tesch, 1990), (Patton, 2002).

This distinction relates to the process by which textual data is coded. While the inductive approach uses the data to generate ideas the deductive method starts with an idea or theoretical framework and uses the data to verify or disprove the idea (Holloway, 1997). Often a combination of both approaches is used. A researcher might start with an inductive coding, trying to identify patterns in the data and establish categories by which the remaining data is coded. In further steps, some theoretical constructs can be consulted to explain and evaluate the categories. Alternatively, prior to the coding process, a coding framework can be established, which is informed by findings in the field of research. Those categories can be related and further developed or changed in the process of coding.

A recent review of design pattern identification produced similar categories of analysis (Brouns et al., 2005), (Baggetun et al., 2007). Brouns et al. (2005) summarized techniques of pattern identification used by various researchers. Although this research discovered many techniques for design patterns identification, little was said about the use of inductive or deductive analysis methods to support pattern articulation. Hence, the relation of design pattern identification and articulation will be the focus in the remaining parts of this paper.

3.1. SETTING AND DATA COLLECTION

The primary data source for my analysis was an undergraduate university design studio subject titled "Only Connect - international collaboration project". This was a 6 to 7-week course organized by the School of Design at the Hong Kong Polytechnic University taught in collaboration with partner universities and design schools in Korea, Austria, Taiwan and the USA. I observed three subsequent courses of this subject from September 2003 to December 2005. Each year groups of 2-4 second year Hong Kong students from product, visual communication and environmental design were paired up with groups of 1-3 students from a similar design discipline and grade from another country. Each time, there were approximately 110 Hong Kong participants and 50 international partners. Each stream had 2-3 tutors from Hong Kong and from each partner university. Students were asked to accomplish a design project, collaborating both remotely and collocated in discipline specific teams. Students received two design briefs. One brief common to the entire course explained the overall project's theme and goal. A tutor in each stream composed a second brief

explaining stream specific tasks and goals. The schedule for this course, which is visualized in Figure 1, was similar throughout the years. In the beginning there was a common subject briefing followed by a “virtual handshake”. This was a video chat connection established with a partner university. After this, teams were divided and matched with the overseas partners. A delegation from one of the partner universities visited Hong Kong for a few days in the first or second week of the course. Teams received several lectures and tutorials throughout the class. Lectures introduced examples and principles of online collaboration as well as theme-specific contents. In addition to lectures, teams worked in local teams to implement design ideas, which were discussed online with the international partner teams. There was an interim presentation of the collaboration progress after week three and a final networked presentation at the end of the project. The Hong Kong teams had to submit a design portfolio one week after the course officially ended.

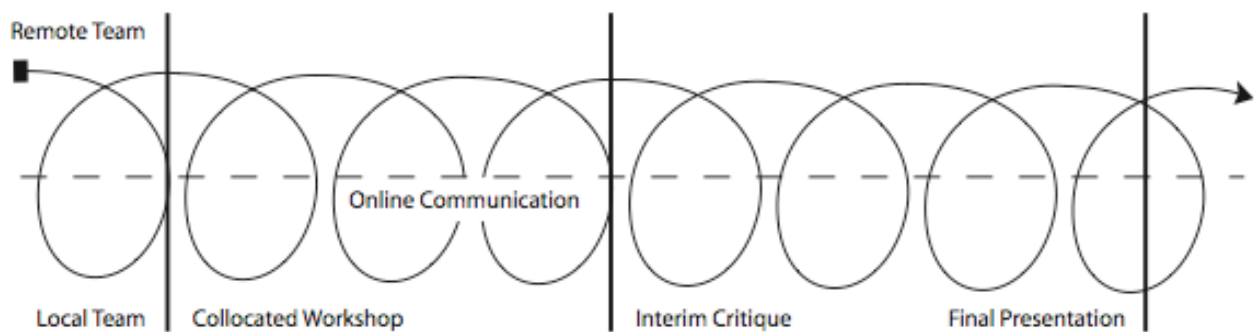


Figure 1 “Only Connect” course timeline.

From geographical locations in Hong Kong, Korea, Austria, the USA and Taiwan students collaborated using various communication technologies. Teams utilized a synchronous communication tool like MSN or ICQ chat systems. Video-chat software was used mainly for university-organized joint presentations but in some instances (Hong Kong – Taiwan) as a regular team-internal communication tool. In addition, teams used asynchronous communication media like e-mail. Different community and group websites were offered throughout the years. In 2003 a shared virtual project and team space on the Internet, the “Only Connect” project website was offered. In 2004 a “Weblog” team space was set up for each team. “Yahoo Groups” were established for teams that collaborated in 2005. In addition, teams were granted server space, which they accessed through file sharing software. The additional server space was necessary because in design collaboration often large file size documents are exchanged between the collaborators. No synchronous collaborative drawing or other design tools were used.

I was a participant observer over the three years of the course. Although my participation differed in intensity among the three years, I was able to take notes of my observations and conduct semi-structured and contextual interviews in all three years. In addition, I was able to collect the log files of the asynchronous

communication on the news-board. In 2004 I had access to the server where teams saved their designs and shared documents and log files of the synchronous communication. Besides the observations and interviews within the "Only Connect" subject, I conducted semi-structured interviews with eleven design experts from the professional and academic domain, who collaborate in international teams. In my interviews I looked for practices employed by those experts to collaborate in intercultural teams. I was interested in teamwork strategies and solutions for overcoming miscommunication and breakdowns in collaboration. The interviewees shared their experiences and visions for computer support technologies, interaction designs and team management in design learning and work environments.

4. DESIGN PATTERNS IDENTIFICATION AND ARTICULATION

This research utilized an ethnographic and evaluative research approach, which incorporated three cycles of observations, analysis and evaluation of the emerging patterns during the three years of this study. In the third year, a comparative analysis was used to distinguish observations made in different cultural contexts in order to validate the design patterns' scope. Figure 2 shows that this research started with an inductive, interpretive analysis of the first year's data. The goal was to discover similarities in the teams' interactions and communications to identify reoccurring issues in intercultural computer-supported collaboration. This was supplemented by data from expert interviews. As a result, several categories that describe reoccurring patterns in cross-cultural collaborative design, remotely or collocated were identified inductively. Thus guidelines for the second year's observations were established, during which semi-structured and contextual interviews were conducted during the course and documents of synchronous and asynchronous communication were collected. Thereafter, the data was analyzed in cycles of inductive coding and deductive mind mapping. A few emerging solutions were evaluated in design scenarios and paper prototypes. These activities produced fourteen design patterns, which were tested in pattern workshops with novice and expert designers. After the evaluation of the workshops, the emergent patterns were developed further using a deductive analysis of the interactions between Hong Kong and Korean participants. The findings were compared with interactions in Austrian – Hong Kong, Taiwanese – Hong Kong and US-American – Hong Kong teams to evaluate the rewritten design patterns. The following sections will explain in detail all stages of the pattern identification and articulation methodology using the pattern MOOD OF THE MOMENT as example.

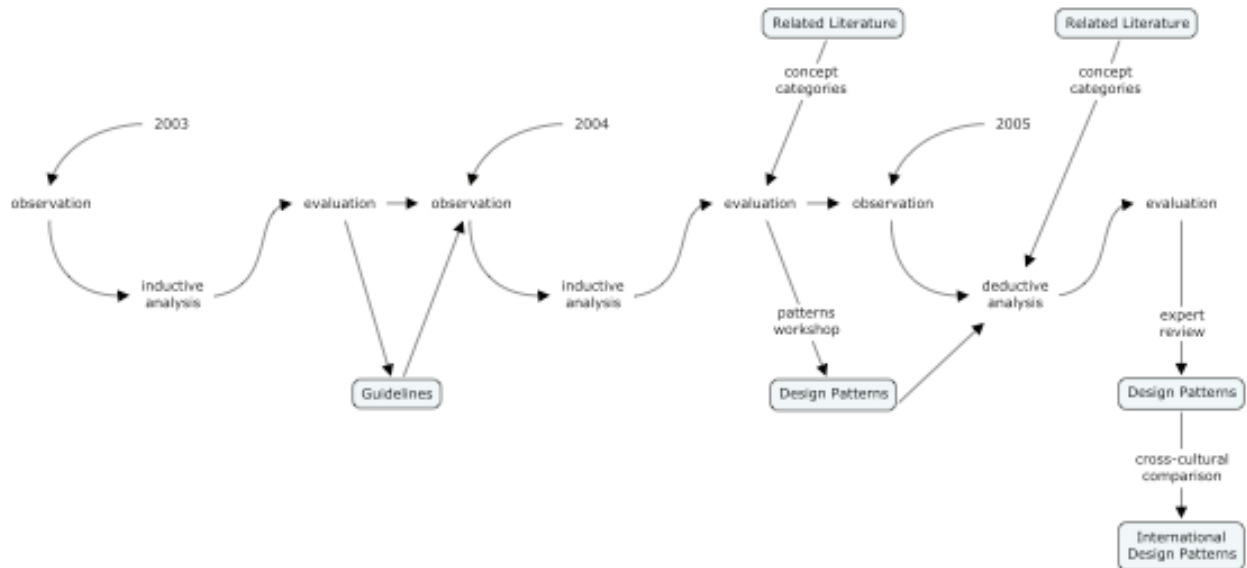


Figure 2: Methodology cycles of observation, analysis and evaluation.

4.1. INDUCTIVE ANALYSIS OF DESIGN PATTERN: "MOOD OF THE MOMENT"

Supporting awareness of online and local events in computer-supported collaboration is an intensively discussed topic in literature. Researchers agree that information on what others were, are and will be doing or feeling improves social awareness in distributed collaboration (Gutwin and Greenberg, 1998). Team members can be aware of other actors or the state of a collaboratively modified object. In the following discussion, unawareness or misinterpretation of another collaborator's mood or emotional response in a conversation was observed to cause breakdowns in the collaboration between Hong Kong and Korean design students. Students partly overcame those problems by using visual icons to support conveying the mood of a computer-mediated textual statement.

The observation of visually supported textual communication was made throughout the different phases of observation and analysis in this study. The preliminary findings from the first inductive analysis of the initial observations and expert interviews covered several emergent themes such as "sharing of feelings", which was identified as a strategy for gaining common ground among international collaborators, shown in Figure 3. However, Figure 3 also illustrates issues that caused breakdowns in collaboration such as "language proficiency", which indicated a limited ability to share feelings in textual intercultural collaboration. These issues were used as a guideline for analyzing the data in the second cycle of this research.

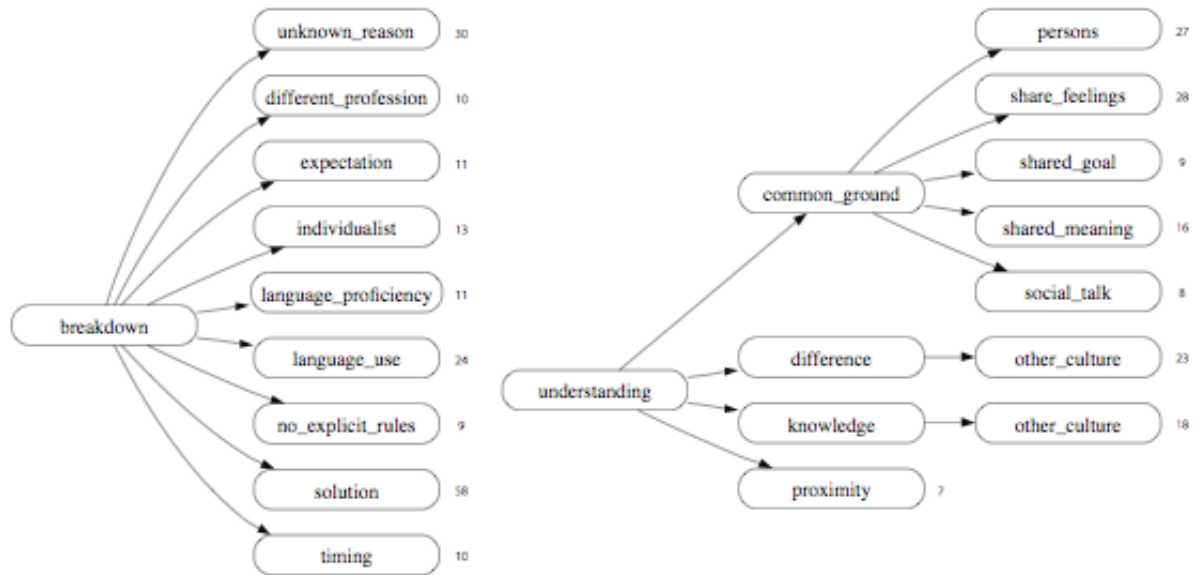


Figure 3: Issues causing breakdowns and allowing gaining a common understanding in international collaboration.

In an effort to affirm and deepen the understanding of reoccurring patterns in intercultural collaboration, the field notes and interview transcripts from the past two years were read several times and the text was segmented into meaningful units in the second cycle of this research. Descriptive notes of those units slowly created an organizational system of recurring topics in my data. This system was refined by constantly comparing the data with the guidelines from the first cycle of this study. As several reoccurring issues were discovered, an interest in identifying possible explanations of why those were recurring issues in intercultural computer-supported collaboration emerged. Therefore, mind-maps of the recurring events were created in order to draw connections between them. The inductive analysis and deductive mind-mapping activity in the second cycle of this research confirmed the use of a variety of “social awareness” indicators in intercultural collaboration, among which one was “mood”. A range of social awareness indicators is displayed in the hierarchical design pattern map in Figure 4.

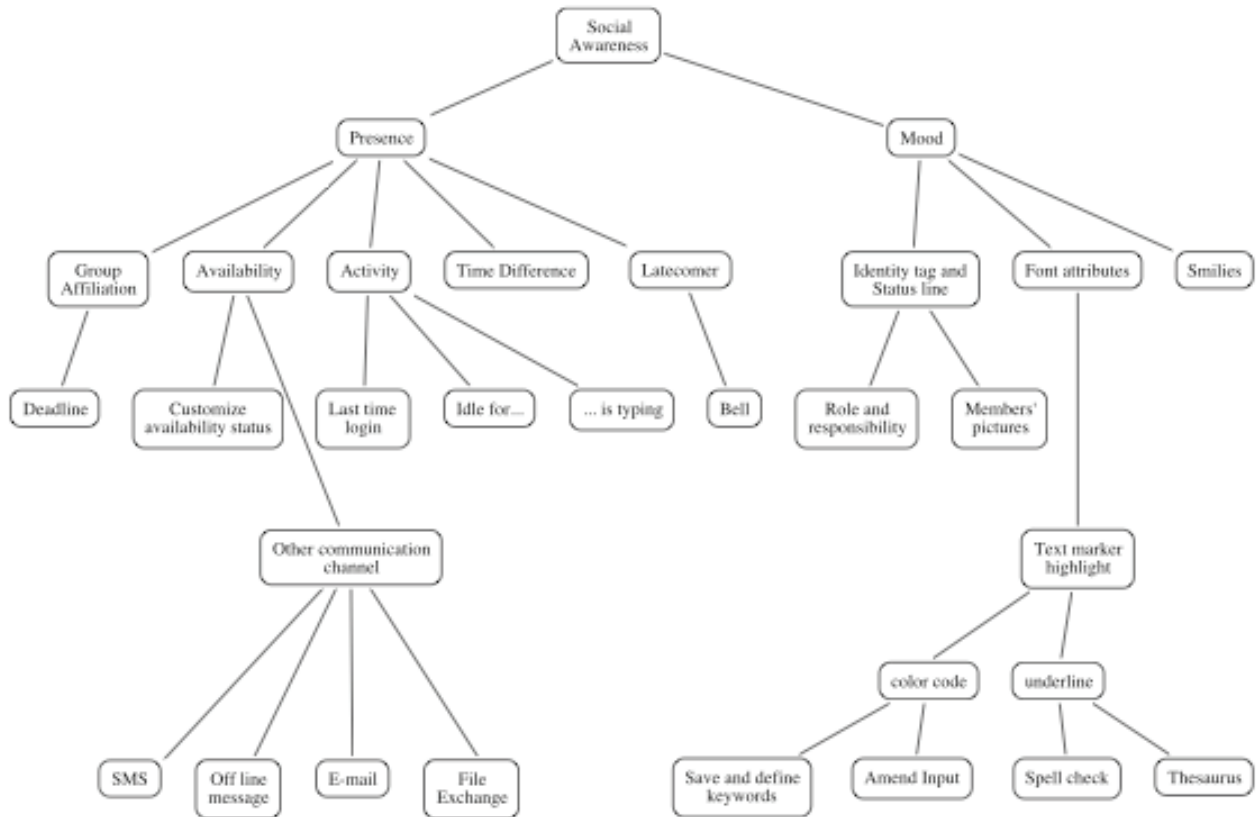


Figure 4: Hierarchical Pattern Map around the observation of “social awareness”

In the displayed pattern map, “mood” was conveyed through textual meta-information such as “smilies”, which are graphical icons of abstract faces that represent various emotionally charged facial expressions. The “status line of the chat account” or textual formatting attributes such as “color” also revealed the “mood” of a collaborator. As conclusion from this analysis, fourteen related design patterns were articulated, among which one was entitled AWARENESS INDICATORS. This design pattern suggested conveying information about past activities, present states and possible future events of members and objects used in the project. In 2005, an evaluative workshop with novice and experienced designers was conducted to investigate how the identified interaction design patterns are perceived and could be used in praxis. Although the evaluators responded generally positive to the scope and applicability of those patterns, some users mentioned that writing style and contents of the patterns could be more focused on descriptions of observations of cultural differences in interaction.

4.2. DEDUCTIVE ANALYSIS OF DESIGN PATTERN: “MOOD OF THE MOMENT”

In reaction to the results of this workshop and other recommendations I received at conferences, I saw the need to rewrite the patterns focusing on communicating which cultural attributes influenced whether or not a solution was good. I needed to work on the consistency of the articulation and naming of patterns in the same language. Therefore, I decided to analyze interactions between Hong Kong – Korean students in-depth using a computer-supported analysis tool. A coding scheme derived from literature of cross-cultural and intercultural communication, design and learning collaboration was used to confirm or dismiss design patterns identified in the first and second year, and reach a more consistent articulation of the design pattern content focusing on the applicability of solutions in several cross-cultural contexts. The deductive analysis mainly used cultural value dimensions identified by several researchers to analyze breakdowns in intercultural collaboration and strategies to gain common ground in international computer-supported collaboration contexts. Academics found similarities between different cultural value orientations (Baumgartner, 2003). Due to those conceptual similarities, several dimensions can be grouped. In my synthesis of the literature, a practical set of grouped dimensions for the analysis of cross-cultural collaborative learning evolved (Kluckhohn, 1950), (Condon and Yousef, 1985), (Hall, 1990), (Victor, 1992), (Triandis, 1994), (Trompenaars and Hampden-Turner, 1994), (Hofstede, 1997), (Schwartz et al., 2001) It consists of:

- ☐ The activity orientation of a member of a culture can be *Achievement* or *Ascription*-oriented.
- ☐ Cultures may have *Hierarchical* or *Equal Authority* conceptions.
- ☐ Communities and societies may differ in *Collective* or *Individual Community* value orientations.
- ☐ *High* versus *Low Contextual Communication* describes a culturally varying phenomenon of how much contextual information is given through verbal or nonverbal language.
- ☐ Communication styles and relations either tend to be *Neutral* or *Affective* in cultures.
- ☐ Standards either build on *Particular* relationships or on *Universal* rules.
- ☐ Cultures either tend to accept and favor technology as a positive tool to *Dominate and Control*, or cultures may see technology as something rather negative that *Controls a Community*.
- ☐ Cultures may differ in *Monochronic*, linear or *Polychronic*, parallel time orientations. *Long Time* cultures respect traditions and long-term commitments. In *Short Time* cultures change happens more easily.
- ☐ The level of tolerance for ambiguity and *Uncertainty (Low or High)* may vary in cultures

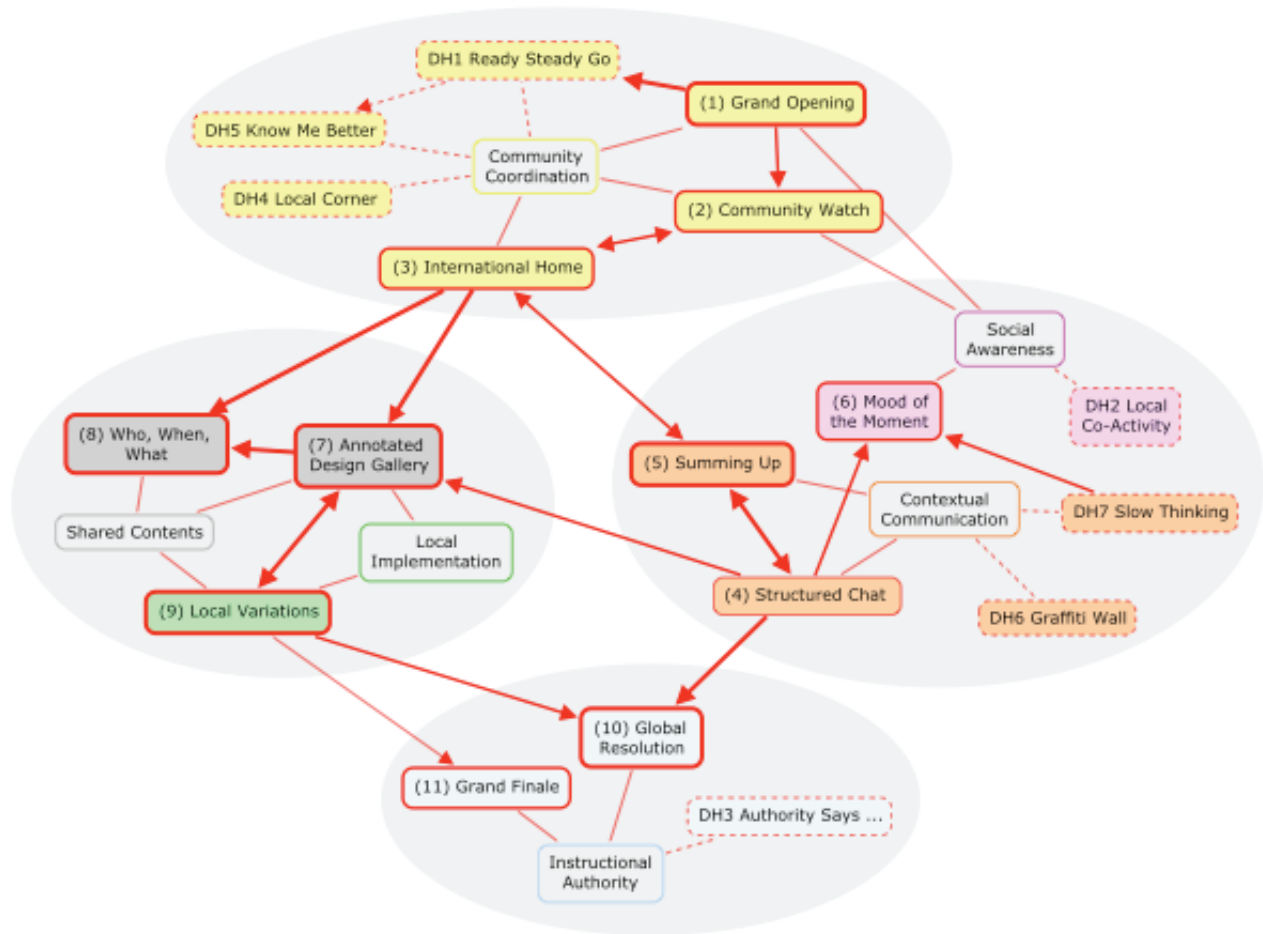


Figure 5: Pattern collection for cross-cultural computer-supported collaborative design learning

Using these guidelines as analytic framework, the data was analyzed deductively. Eleven patterns were identified and articulated in this analysis, which are shown in Figure 5. Taking the pattern MOOD OF THE MOMENT for example, recurring breakdowns in emotionally misunderstood textual conversations were analyzed first using this deductive framework. The analysis revealed that unawareness of affective relations to the scope of the discussed designs caused breakdowns in communication between *Affective Communicating* Korean and more *Neutral Communicating* Hong Kong students. *Collective Community* and relatively *High Contextual Communication* styles dominated the conversations. That means students did not explicitly state their opinion, especially when they have opposing views, but rather tried to cycle around the issue and repeat their views. Through this repetition, students want to show their discontent indirectly. This is also influenced by a perception of *Universal* or *Particular Standards* in design. Koreans repeatedly discuss the scope of the project and various related design ideas in order to establish a consistent holistic understanding of the design space. However, the Hong Kong collaborators who have a *Particular Standard* orientation and strive for *Achievements* do not analyze one solution in-depth. In their view, if a subject matter needs to be discussed a lot, it is probably

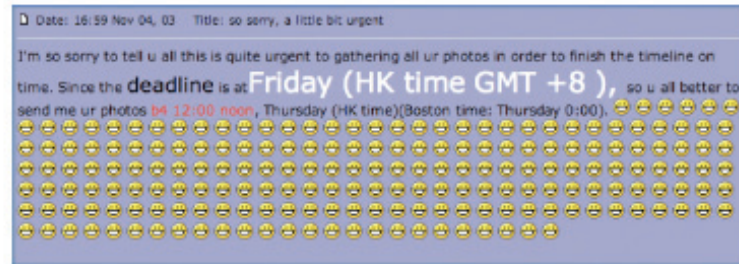
Expressing mood in conversations in order to make participants aware of social relations and affections in the design process was a successful solution in the Hong Kong/Korean collaboration. Lukosch and Schummer (2006) reported on a pattern called DIGITAL EMOTIONS in computer-supported collaboration. However, research into intercultural collaboration does not mention affective communication as an explicit intercultural communication means. Intercultural awareness tends to be interpreted as being restricted to rational understanding of cultural differences and reflective understanding of other cultures' ways of thinking. Only this study supports the idea of affective communication support, at least in collaboration between Hong Kong and Korean students. This finding was compared to communication and social awareness strategies in Hong Kong/Taiwan, Hong Kong/Austrian and Hong Kong/US-American collaborations.

Breakdowns in textual communication in Hong Kong/Korean and Hong Kong/Taiwanese could be resolved with conveying the mood of a message through signs and symbols, pictures or text formatting options in distributed computer-supported conversation. On the other hand, in the interaction between Hong Kong and US-American students, emoticons or other affective communication means were clearly used by Hong Kong students only and were hence not an explicit support to intercultural communication in this cultural setting.

However, it was more difficult to compare the success of Hong Kong and Austrian students' *Affective Communication*. Over the two years of observation, some students used emoticons to communicate while others did not. Some Austrian students perceived the collaboration as less serious when too much affection was communicated by Hong Kong. However, Austrian students used emoticons in moderation, too. This ambivalence in the successfulness might be attributed to the mixed orientations captured in the cultural context cause. Although Austrian students differ from Hong Kong students in their *Individualistic Community* and *Low Contextual Communication* orientations, this *Affective Communication* also bridges differences in *Affective* and *Neutral Relation* oriented cultures, which seemed to be the case in the Hong Kong/Austrian collaboration. In this case, a dichromatic comparison is not very effective to clearly identify the success of conveying mood in communication between Austrian and Hong Kong students.

The relation of breakdowns in communication between *Collective Community* cultures and the positive use of indirect and *High Contextual Communication* supported by visual means will be introduced by the design pattern MOOD OF THE MOMENT illustrated in Figure 8. The design pattern also suggests in which cultural contexts this pattern might be more effective than in others.

DP 6: MOOD OF THE MOMENT **



Thumbnail Support the awareness of implicitly conveyed but important message contents with emotional value through visual communication means.

Cultural Context Supports *Collective Community* and *High Contextual Communication* cultures. Bridges *Ascription* and *Achievement* and *Affective* and *Neutral Relationship*, *Long* and *Short Time* cultures. This pattern was observed in collaboration between Hong Kong and Korea, Hong Kong and Taiwan, and Hong Kong and Austria.

Context Distributed students use STRUCTURED CHAT and SLOW THINKING to communicate design ideas and coordinate local activities in textual, written conversation.

Breakdown In the collaboration of design learning teams, breakdowns in communication occurred based on difficulties in conveying the importance of upcoming deadlines in teamwork. Students tried to give more emotional value to design ideas in textual communication in English language. However, due to low English language proficiency, conversations that were meant to clarify understandings and giving an emotional meaning to the proposed design ended up being long and tedious, releasing participants in dissatisfaction.

Problem How can you support conveying mood and emotions in distributed intercultural communication?

Forces Collective Community cultures seldom express their feelings and views explicitly in textual communication. Moreover, they have problems expressing the appropriate mood in English language. Although Affective and Ascription cultures want to give the contents of a textual message more expressiveness, communicating in a second language is difficult. Hence, such cultures implicitly return to an unresolved issue throughout the entire collaboration. However, since direct and explicit communication of a problematic issue is considered impolite, indirect and cycling statements complicate the communication of an important position for these cultures. The collaborator has difficulties understanding the point of concern. Due to time constraints, this issue is dismissed but not resolved. Long Time oriented cultures do not necessarily see this shift as final and take up the topic in another conversation. This is problematic for representatives of Short Time and Achievement cultures, who thought the issue was forgotten. They get annoyed and become more direct in their communication, which is considered impolite by the collaborators.

Solution Offer a choice of visual communication means such as graphical icons or text formatting tools to support awareness of the mood and emotional values in a textually mediated statement.

Why Collective Community, Affective, and High Contextual Communication cultures have difficulties expressing emotions explicitly in textual computer-supported communication. Visual communication means implicitly conveying the mood of a textual statement. Furthermore, visual means may also reduce the explicitness of textual messages since it is considered impolite or even rude to assign a task or communicate a decision directly in Collective Community and High Contextual Communication cultures. Giving more expressiveness might not always avoid a breakdown but makes participants more aware of the importance of an issue, so that it is not easily dismissed or overlooked.

Resulting Context Allowing users to synchronously draw their ideas using the pattern GRAFFITI WALL can also support textual synchronous conversation. Moreover, local design activities that are often carried out in parallel to online chat can be indicated indirectly in a chat conversation using the pattern LOCAL CO-ACTIVITY.

Related Work Schuemmer (2004) proposed a related pattern, entitled DIGITAL EMOTIONS.

Figure 8: Design Pattern MOOD OF THE MOMENT

5. CONCLUSIONS

Literature has proposed that the identification of patterns is largely experience based. This could be confirmed by this research. This study also confirmed that engaging in ethnographically informed inquiry helps to structure the experiences and observations of problems and successful solutions into design patterns. An inductive analysis method was used to generalize the observations and develop categories to guide further observations.

As discussed in this paper, researchers have discussed inductive and deductive methods of pattern identification. However, pattern articulation has received much less attention in research. Reasoning and interpretation moves from general principles and theories to the particular and specific predictions such as a design pattern in this research. The deductive analysis helped achieve a persistent textual description, use of language and syntax, structure and format for a design pattern. Hence, the pattern format was adapted to the needs of communicating cultural differences in problems and design solutions for supporting collaboration.

This is shown in the following pattern structure analysis:

- Name: Finding an inspiring name for a cross-cultural design pattern proved difficult. However, collaboration support mechanisms hinted at the underlying social principle of this pattern that should be communicated by the pattern name.
- Cultural Context: The cultural context description introduces the cultural value dimensions that are supported and bridged in this pattern to make it easier for pattern users to identify if their problem has a similar context. If not, the reader might not find this pattern useful.
- Context: The original context description references previously identified patterns.
- Breakdown: Observation of breakdowns in communication animated me to include such a description of breakdowns in my pattern format. Breakdowns are likely to reoccur in similar collaboration contexts. Furthermore, the identification of breakdowns is relatively ``easy". However, identifying reasons for breakdowns is not that easy.
- Problem: A final problem description derived from the breakdown scenario identified in this context and the support mechanisms that were identified to be missing.

- Forces: Forces give a transition of conflicting cultural value dimensions that cause a breakdown in collaboration and which need to be resolved in order to support collaboration between cultures with those cultural value orientations.
- Solution: The solution proposed the use of support mechanisms to gain common ground or deal with breakdowns in intercultural collaboration.
- Why: The “Why” section explains the solution in the light of potentially conflicting cultural value orientations that are resolved by the solution. This section helps the reader to better understand the reasons for using the solutions.
- Resulting Context: This context is the result of applying the proposed solution is used in the original context. Related patterns are referred to in this section.
- References: The reference section mentions related work in patterns or other format where the reader can learn more about some aspects of the pattern or get additional ideas for using this pattern.

In the above outlined pattern format for communicating solutions for supporting intercultural collaboration, the sections “Cultural Context” and “Breakdown” are entirely new additions to previously proposed design pattern formats. Those sections are valuable to design patterns intended to make users aware of cross-cultural differences in the proposed solutions. However, a drawback of using cultural value dimensions to convey the reasons behind problems and solutions in patterns is that the reader might have difficulties in understanding every aspect of the pattern initially. Those dimensions are not always intuitive. If an untrained person reads it, knowledge about the meaning of cross-cultural dimensions needs to be gained first.

This research found that inductive methods are valuable to identify design patterns from within the practice, but deductive analysis methods support the articulation of patterns. A theoretically informed coding-scheme to analyze observations supports keeping the focus in pattern composition. A combination of both analysis methods is advisable for analyzing cross-cultural collaboration design patterns. In addition, a comparative analysis supports the evaluation the validity of patterns across cultural contexts.

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